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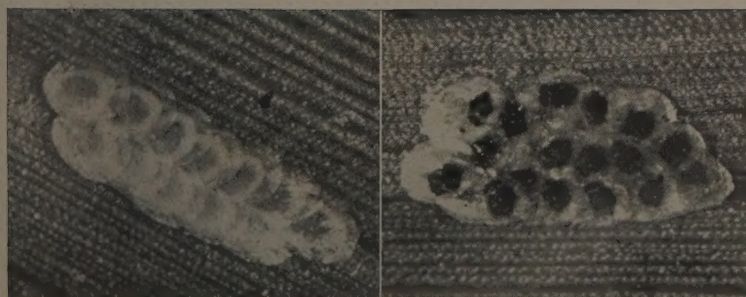
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EUROPEAN CORN BORER CONTROL

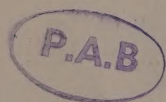
JOHN H. HAWKINS



Eggs of the European corn borer enlarged about fifteen times. Eggs on the left are newly laid. Those on the right are in the black-head stage and about to hatch.

CONTENTS

	PAGE
Winter survival.....	3
Summer mortality.....	3
Moth emergence.....	3
Only newly hatched borers controlled by insecticides.....	4
Finding the eggs of the European corn borer.....	4
Insecticides used in European corn borer control.....	5
Research and Extension give information on time to apply.....	5
Effectiveness of single applications.....	6
Rain following the application of insecticides.....	6
Three versus four applications.....	6
The use of dilute liquid sprays.....	6
Nozzles and their arrangement.....	7
Arrangement of spray booms.....	9
Clearance beneath machinery.....	9
The number of rows treated.....	10
Spacing the distance between corn rows.....	10
Insecticides—how much and how often.....	10
Operators of sprayers and dusters.....	11
Low pressure, low gallonage sprayers.....	12
Liquid dusters.....	13
The use of hand dusters.....	13
Parasitic control of the European corn borer.....	13
Fall armyworm infestation.....	13
Is cultural control practicable?.....	14
Insecticidal control practical.....	15
Borer control on an area basis.....	15



EUROPEAN CORN BORER CONTROL

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It is an established fact that the European corn borer can be controlled. The purpose of this bulletin is to serve as a guide to those who wish to take part in the effort to stop needless injury to the corn crop. (See Fig. 1.) It is hoped that the relatively small group now actively engaged in combatting the borer menace will be greatly increased. The active participation in a cooperative effort by home and market gardeners as well as those growing larger acreages of corn is badly needed. Unless this is forthcoming it is likely that profitable corn production in Maine will become increasingly difficult.

Winter Survival. About 97 per cent of the hibernating corn borers survived the winter of 1947-48, although temperatures as low as -24°F . existed in parts of Maine where the borers hibernated. Normally about two-thirds of the borers which survived the winter mature to the adult moth stage capable of reproduction. The winter of 1948 was not greatly different from previous years in its effect on corn borer survival.

Summer Mortality. Borers hatched from only 44 per cent of the eggs on corn in experimental plots, and of those hatched but 26 per cent survived long enough to become established in the corn plants. Low percentage survival of the eggs and the very young or first instar larvae has previously been observed. Data obtained point to the fact that unfavorable summer weather such as light wind and heavy showers is likely to exert greater natural control over the European corn borer than can be expected from low temperatures during winter.

Moth Emergence. The emergence of the moths of the European corn borer precedes egg laying and hatching by fairly regular time intervals. When there is a rapid rise in moth emergence there is a corresponding rise in hatching of the eggs laid by these moths about 11 or 12 days later. Therefore, by watching the emergence of the moths in rearing cages, it is possible to foretell at about what time the eggs will hatch and when insecticides can be applied to effectively control

¹ The assistance of J. J. Devitt, Gerry Buzzell, and Richard Thurston is acknowledged in securing field data upon which this bulletin is based. Thanks are due to Dr. F. H. Lathrop and J. C. Hickey for reading and suggestions in arranging the manuscript. All the photographs in the bulletin were made by S. E. Northsen.



FIGURE 1. Ears of sweet corn discarded at canning factory because of corn borer injury (left). Breakage of corn plants caused by borer injury resulting in about a 50 per cent loss to the grower in this field (right).

the small borers. Applied at hatching time, insecticides effectively control the young borers before they can bore into the plants.

Only Newly Hatched Borers Controlled by Insecticides. That only the newly hatched larvae are killed by the application of insecticides can be assumed for practical purposes for it is rarely that the borers are killed after they once become established in the corn plants. In view of this fact, the applications timed to catch the very young larvae, just after hatching, are those most effective in the control of the European corn borer. Therefore the first application should be made as soon as the hatching occurs.

Finding the Eggs of the European Corn Borer. The eggs of the European corn borer are small, whitish in color and resemble small fish scales. (See Front cover.) They are flat, overlapping each other, and shiny white as seen against the green of the corn leaves. The eggs are mostly laid on the underneath sides of the second, third, or fourth leaves from the base of the corn plant. They can be seen only by lifting up the leaves and looking for them. The eggs are most easily found on

rapidly growing corn in early planted fields. Unless the observer is patient, careful, and has time to make a thorough examination, many eggs are likely to be overlooked, and the first application may be too long postponed. If this error is made, successful insecticidal control cannot be obtained.

Insecticides Used in European Corn Borer Control. Results obtained from the use of Ryania and DDT continued to be satisfactory during 1948. Each insecticide has proven to be up to 96 per cent effective in borer control. Ryania has an advantage over DDT in that it is relatively safe for use on corn where any part of the crop is to be used for feeding livestock. It is more expensive than DDT and there appears to be little chance that it will be produced much more cheaply than it is at present.

The danger of using DDT on corn fed to livestock is not that the residues are excessive, but that even small residues are accumulative in the flesh and milk of animals. The fat of the animals and the butterfat produced are especially susceptible to absorption of DDT. It is interesting to note that, although small amounts of DDT were found on corn samples during 1947, similar samples from corn plots treated four times with DDT used at the rate of 51 pounds per treatment during 1948 showed no trace of DDT when analyzed by the Experiment Station Chemistry Department.

Parathion, a new insecticide, used at a 2 per cent concentration in dust form was 87.8 per cent effective as compared to 96.3 per cent obtained from a 5 per cent DDT dust. The danger of toxic effect on operators using Parathion, the uncertainty of costs, the source of supply and toxic residues are factors needing further investigation. A residue of Parathion amounting to two tenths of one part per million by weight of corn was found on corn samples taken from plots treated 4 times with a 2 per cent Parathion dust the last application being made 33 days before harvest.

A new material designated as DDD used in experimental plots resulted in 93.5 per cent control. This new material is being investigated further, because it is believed that there is relatively little danger of toxic residues on corn treated with DDD as compared to DDT.²

Research and Extension Give Information on Time to Apply. The research staff of the Experiment Station is confining the European corn borers in cages in order to determine when the moths emerge and lay eggs. The emergence of the moths in the cages corresponds to the flight

² According to recent information DDD along with DDT and other chlorinated hydrocarbons are not safe to use on corn where the fodder or corn waste is fed to livestock.

in the corn fields. When the main flight occurs it is time to look for the eggs. It is also true that the eggs hatch in 11 or 12 days after the moths begin to emerge in large numbers. With these data, county agents and other Extension workers are ready to assist in finding the eggs and to advise as to the time when the first application of insecticide will be most effective.

Corn 10 or 12 inches in height at the time when the moths are flying in large numbers is very likely to be infested. Consequently some growers apply insecticides to their early corn without attempting to find the eggs. Late corn is seldom heavily infested by the borers; therefore if the fields can be closely watched but a small amount of the late corn will need to be treated.

Effectiveness of Single Application. A single application of 40 per cent Ryania dust made on July 31, 1948, controlled 45 per cent of the European corn borers present. Another single application made on August 6 was 40 per cent effective. The first application was made during the rapid rise in hatching and the second single application was made at the time when the peak of hatching had been reached. There is evidence to show that insecticides used in corn borer control remain effective for about five days following their application. The single applications covering the periods of July 31 to August 6 and from August 6 to August 11 were effective during the time when most of the borers were hatching. The data show what can be done with single applications of insecticides and suggest further possibilities if all three treatments could be applied at times of greatest borer hatch.

Rain Following the Application of Insecticides. First applications of insecticides made to corn in the 1947 experimental plots were ineffective in controlling the European corn borer. Rain beginning soon after the applications were made, continued for a five-day period for a total of 1.2 inches. Having insecticides rained off is no new experience but the complete removal of the toxic principles of the insecticide during 1947 points directly to the value of adjusting treatment schedules to conform to periods when there is likely to be a few days of dry weather.

Three Versus Four Applications. An average increase of 4.3 per cent control of corn borers has been obtained when four applications of insecticide were made as compared to only three. The general conclusion from three years data is that more than three applications are not justified, if the three applications are made at the most critical time and are not washed off by rain. An exception to this would be when high prices for corn would justify an additional treatment at the end of the season.

The Use of Dilute Liquid Sprays. Insecticides applied as dilute

sprays containing 4 pounds of powdered Ryania (Ryanex 100-S) or 2 pounds of 50 per cent DDT were used during the past season. Results obtained were 81.4 per cent control for the Ryania and 86.0 per cent for the DDT. These sprays were conditioned with a wetting and spreading agent to increase their efficiency. Ultrawet-E, Areskap, or Triton X-100 are used as wetting agents and are used at the rate of one-third pound per 100 gallons of water. It was found that incorporation of the wetting and spreading agent in warm, soft water 12 hours or more ahead of use, facilitated operations, especially in obtaining a suspension of the Ryania in the water so it would not clog up the spraying equipment. Complete directions for spraying will be sent by the Maine Agricultural Experiment Station upon request.

Nozzles and Their Arrangement. The nozzles finally found most satisfactory were ordinary spray nozzles with the whirl plates drilled in the center with a 3/64 inch drill in order to secure a solid cone spray. Spray disks used were number 4 in size. A pressure of 250 to 275 pounds was maintained at the spray pump and about 100 to 125 gallons of spray was applied per acre. It was difficult to apply enough spray to obtain runoff at the bases of the corn plants as recommended. The spray nozzles were arranged in threes as shown in Figure 3.

The nozzles are adjustable on the spray arms and booms so that as the corn plant becomes larger the two lateral nozzles can be directed to spray the ear shoots as they develop. In applying insecticides in dust form, the fan-shaped nozzles are arranged in twos or threes for each corn row. The arrangement of three is similar to that for spraying. The center nozzle is carried about five inches above the corn plant and

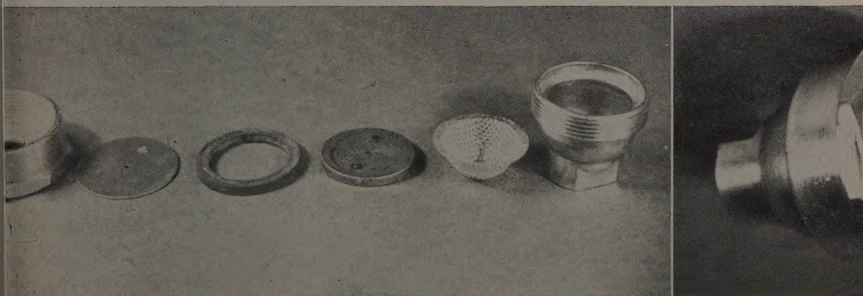


FIGURE 2. The type of nozzle commonly used in spraying sweet corn. This nozzle is used to produce a solid cone spray with water sprays. In the picture to the left the whirl plate (fourth from the left) has been drilled in the center to produce a solid cone spray pattern.

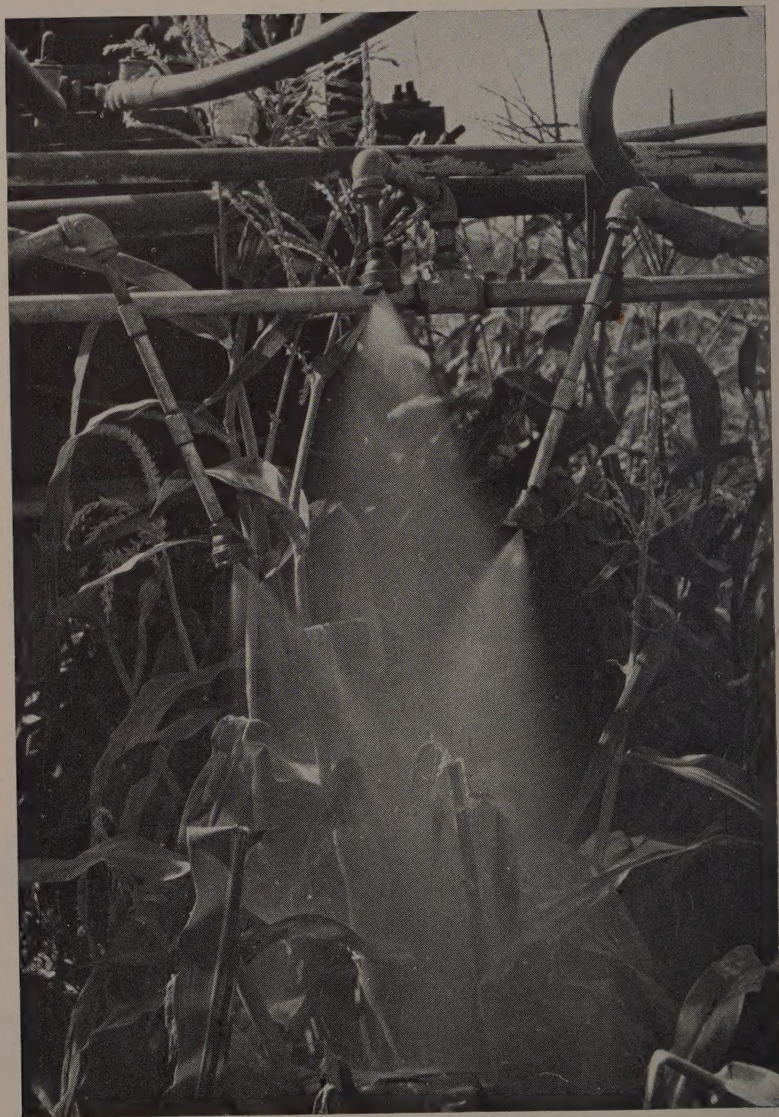


FIGURE 3. Nozzles in action showing the spray pattern for spraying after ears are formed. The spray is being concentrated on the corn ears and at the junctions of leaves with the corn stalk.

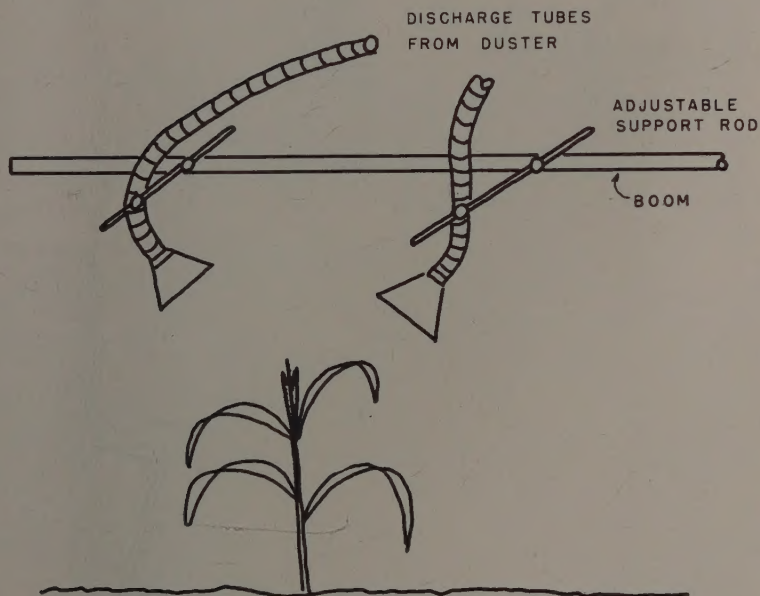


FIGURE 4. Diagram showing the arrangement of duster outlet nozzles when there are but two outlets to each corn row.

is directed downward toward the whorl. The two lateral nozzles are set at angles to cover leaf junctions with the main stalk and to cover the ear shoots. When but two nozzles are used they are arranged as shown in Figure 4.

Arrangement of Spray Booms. Corn plants bent over by sprayers or dusters when treated are not effectively covered because the material is not concentrated in the whorl or at the leaf bases. An improvement is to have the spray boom and nozzles carried high enough and far enough in the rear or in front of the machinery so that the corn plants are erect when treated. Lengthening of duster tubes and attaching of the boom farther in the rear of the duster would solve the problem where dust is used. The spray boom could be carried farther in the rear or in front of the tractor hauling the machinery.

Clearance Beneath Machinery. A clearance of about 20 inches beneath tractors and machinery used in applying insecticides has been reported as satisfactory in the Central West. With this clearance sweet corn in tassel is not usually badly broken. Clearance of 24 to 27 inches has been obtained on experimental machinery by using high clearance jockey type carts for dusters and sprayers and larger wheels and tires

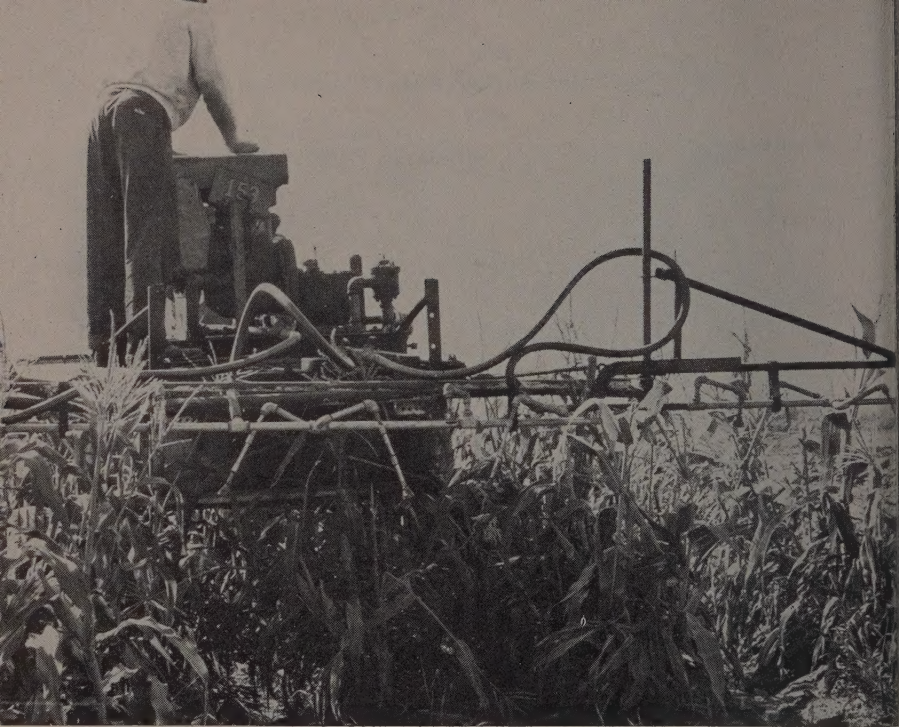


FIGURE 5. Rear view of sprayer to show height of spray boom for treating corn after ear shoots are formed.

for tractors. The machines with 24 to 27 inch clearance beneath them are satisfactory from the standpoint of operation and in preventing excessive breaking of the corn plants.

The Number of Rows Treated. Most of the dusters and sprayers now in operation will treat from 4 to 8 rows at a time. It is necessary to see that pressure to outside nozzles is not cut down because of the distance from the source of power. Stepping up the number of revolutions per minute will overcome some of the loss of power to outside duster and spray nozzles.

Spacing the Distance Between Corn Rows. Dusters or sprayers of the row-crop type cannot be used effectively in European corn borer control unless the corn is planted so that the rows are spaced about the same distance from each other over the entire field. Otherwise results will be disappointing because much of the insecticide will be wasted between the corn rows.

Insecticides—How Much and How Often. The less the amount of insecticide used per acre the more economical, providing control of the borers is obtained. Too much material may cause crop injury, increase



FIGURE 6. Duster in action. The first dust application is being made to early corn. The three nozzles to each row arrangement is being used and the proper height beneath tractor and duster is being maintained.

harmful insecticidal residues and increase cost of treatment without increasing borer control. Therefore, dusters are adjusted to put on as nearly as possible to 40 pounds of 5 per cent DDT dust, 45 pounds of 3 per cent DDT dust or 45 pounds of a 40 per cent Ryania dust per acre. Sprayers are adjusted to apply enough spray to cause some runoff at the base of the corn plant but not so much that there is excessive waste. From 100 to 150 gallons of spray are the amounts used per acre depending upon the size and stand of corn plants.

Three applications of dusts or sprays used at five-day intervals have proven adequate in controlling the European corn borer unless rain washes off the insecticide. Trials of dusters and sprayers previous to their field use helps in applying the proper amount per acre. Coordinating the speed of the tractor drawing the machine with the amount of material per acre is necessary to proper application.

Operators of Sprayers and Dusters. Results are likely to be discouraging if the operator of a duster or sprayer is not careful or if directions are not followed. Dusting and spraying of corn is not a difficult task for the average farm operator or his helpers, providing the fundamentals of applying insecticides are understood and care is



FIGURE 7. Tractor used for treating corn. Clearance beneath the tractor was obtained by the use of large tires and rims attached by means of hub extensions. Suitable for use on corn in tassel stage.

used in doing the work. Treatment of corn differs from general use of insecticides in that instead of spreading the material evenly it is necessary to concentrate the insecticide to the whorl, leaf bases, and ear shoots of the corn plants. Better borer control usually results as experience in the application of insecticides is gained. Insecticides are dangerous if inhaled or allowed to come in close contact with the skin. Therefore, operators should wear masks and gloves when dusting or spraying, and any insecticide coming in contact with the skin should be washed off before it can cause injury.

Low Pressure, Low Gallonage Sprayers. Low pressure, low gallonage sprayers are being experimented with in European corn borer control. These sprayers use $\frac{1}{2}$ to less than $\frac{1}{4}$ the amount of water used in ordinary dilute water sprays. This advantage of less weight and the fact that the machines are relatively inexpensive is of interest. However, such information as is available places them in the experimental stage. They apparently require considerable skill in operation to place the concentrated sprays on those portions of the corn plants where the young corn borers feed.

Liquid Dusters. Another innovation being considered for corn borer control is the liquid duster. A small amount of liquid is carried along with the dust and applied at the same time. The result is that the dust being wet sticks where it is applied. This type of duster is still in the experimental stage under Maine conditions. If these machines prove effective, they should make it possible to apply dust during windy days when ordinary dusters cannot be used effectively. Liquid dusters are relatively high in cost.

The Use of Hand Dusters. Good results in the control of the European corn borer were obtained from the application of insecticides with the crank-type hand duster. Amounts of insecticides in excess of those needed are usually applied, because hand dusters are especially difficult to regulate and operate to obtain light, even applications. Considerably more labor is involved in the operation of hand-operated dusters as compared to that required to operate power machines. However, for small acreages where labor is available, the hand-operated machine is economical because of its relatively low cost. Market and home gardeners can control the corn borers with hand dusters when the cost of the additional materials used is consistent with the value of the corn produced. It is also possible that growers of small fields of canning corn can control the borers economically by applying insecticides with hand-operated dusters.

Parasitic Control of the European Corn Borer. One of the first methods advocated for the control of the corn borer was the use of other insects which are parasites. The rearing and liberation of parasites have been carried on continuously for many years. Considerable progress has been made in this work. However, the borers still persist in the areas where the parasites have been liberated. At the present time it is not likely that the liberation of parasites in any locality will suddenly take the place of insecticidal and other forms of control. It is expected that more parasites will be released in Maine and if they become established it is hoped that the results will supplement other control measures. Some native parasites have been found in small numbers and some of the predaceous insects recently found feeding upon the young borers may be helpful in keeping the corn borer population from becoming overwhelming.

Fall Armyworm Infestation. The fall armyworm infestation of the ears of sweet corn was the worst on record for Maine during the growing season of 1948. The injury caused to the corn ears was extensive, large portions of the ears being consumed in many cases. The fall armyworm cannot survive the winter in northern latitudes and since it comes into the State entirely by flight no one can tell with certainty when there

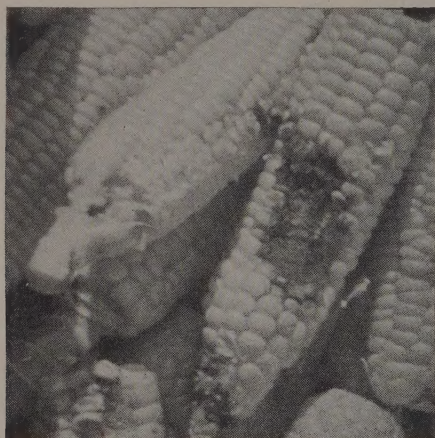


FIGURE 8. An ear of sweet corn showing the type of extensive injury caused by the fall armyworm.

will be another infestation. Since it does not winter here farm practices such as plowing and cleaning up of infested plant materials are not effective in fall armyworm control.

Some of the insecticides used against the European corn borer such as DDT, Parathion, and DDD are reported to be effective in fall armyworm control.

Applications of insecticides made during July and early August for European corn borers are not very effective against the main fall armyworm infestation. Insecticide treatments made as near to harvest time as practicable would produce much better control of the armyworms.

A major difficulty in insecticidal control of the fall armyworm is that of finding them before they have entered the corn ears. Information on the most effective insecticides and when and how they should be applied is needed and may become imperative if future fall armyworm infestations of sweet corn are as severe as that experienced during the fall of 1948.

Is Cultural Control Practicable? Information obtained over several years has shown that corn stalks on the surface of fields are the principal source of European corn borer infestations. There are many fields in which the stalks are left exposed by poor plowing. The situation is made still worse by harrowing and when the fields are finally ready for planting the pieces of corn stalks are scattered over the entire surface of the field. If growers could be induced to plow and harrow carefully

there would then be a minimum of corn stalks left on the surface. Then if the stalks were picked up and destroyed the corn borer menace would be greatly reduced. Is it impractical to do this? It is probable that farm practices are the least expensive of all corn borer control measures. In addition those participating in such a program are performing a distinct service to the community.

Insecticidal Control Practical. Where cultural control of the corn borer is impractical or unattainable as it now seems to be, it is still possible to control the corn borer economically by using insecticides. The cost of insecticidal control amounts to 15 to 20 dollars per acre as now used. There are many fields in which the loss due to low quality of corn and reduction in yield from borer injury have been much in excess of the cost of insecticidal control. It is possible to use insecticides and be assured that borers will not cause the loss of the crop, regardless of how bad and how near are the sources of infestation from corn stalks left on the surface from the previous year's infested corn crop.

Borer Control on An Area Basis. There is a great need for greater participation in the fight against the corn borer. A cooperative program in which all growers would use all their facilities to combat the borers would prevent much of the losses now caused and reduce the possibilities of yet more serious borer devastations. This would involve all possible control methods including clean plowing, careful harrowing, cleaning up infested material after harrowing, cleaning up around buildings and feed lots and the judicious use of insecticides especially in early corn where borer infestations are often heavy. Until this is done it is likely that it will be necessary to treat increasingly large corn acreages each year in order to produce corn which can be used or sold at a profit.

